

Status of J/ψ in d+Au run8

- 200GeV
- Production P08ic
- MinBias Trigger
- 39M events, 33M in $|V_z| < 50\text{cm}$
- Geometry: TPC and EMC

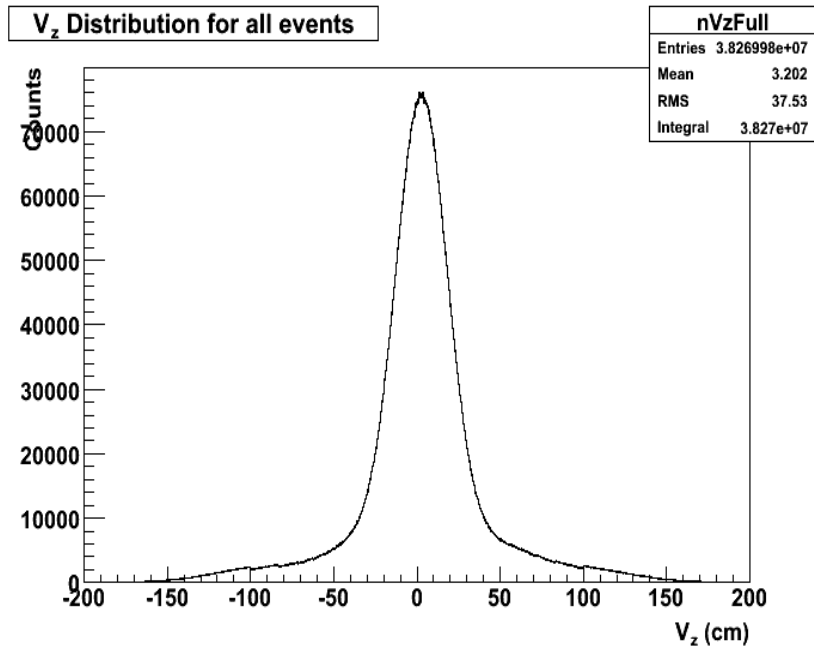
Chris Powell

Lawrence Berkeley Laboratory/
University of Cape Town

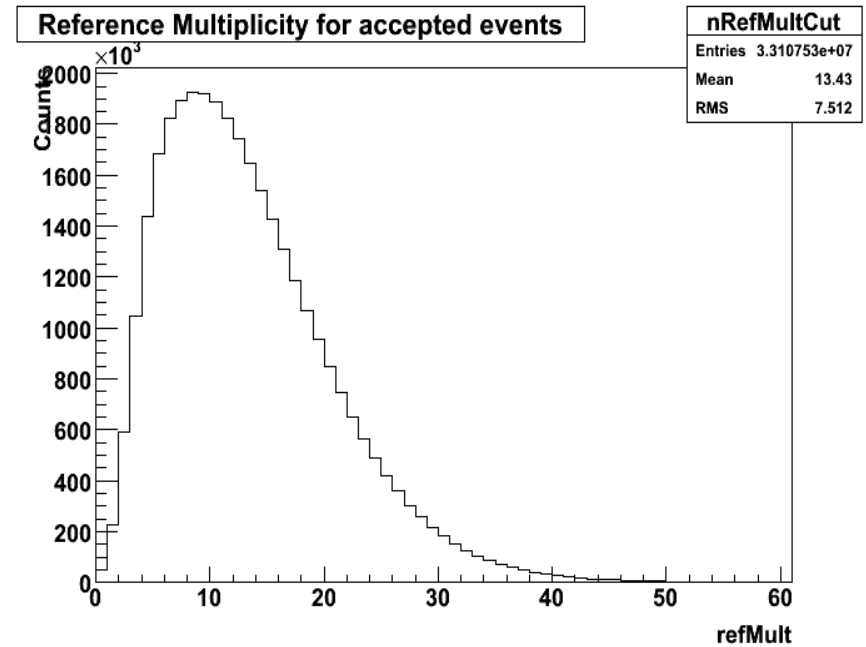
Outline

- Quality of data
- EMC tower energy
 - PID using p/E
- J/ψ signal and significance
 - pT bins

Quality of the data



V_z for all events



RefMult for accepted events

This is approximately 83% of the
produced d+Au data

Event Cuts: $|V_z| < 50\text{cm} \ \&\& \ \mathbf{V} \neq (0,0,0)$
(33M events)

Corrupt Events:

Gene van Buren reported instances where the 1-second RICH scaler rates were incorrectly 'stuck' at values 2 or 3 times too high.

(see <http://drupal.star.bnl.gov/STAR/blog-entry/genevb/2008/nov/21/cutScalerCorruption>)

This can have a large impact on how TPC distortions are corrected. Working with Gene, I devised a set of cuts to remove these events (~0.6% of minBias events) on the analysis level.

(see http://pdsfweb01.nersc.gov/~cpowell/dAu_2008/scalerAnalysis/2009_2_dAu08_scalers.pdf)

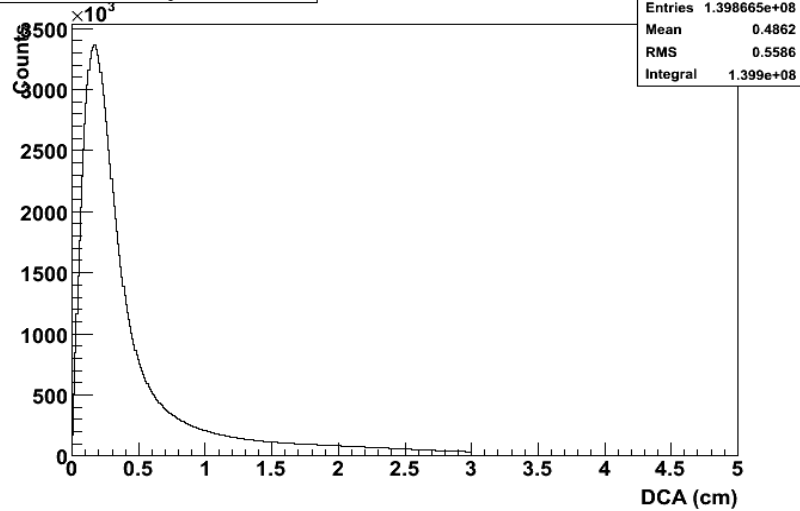
Quality Cuts:

Accept tracks which
pass these cuts

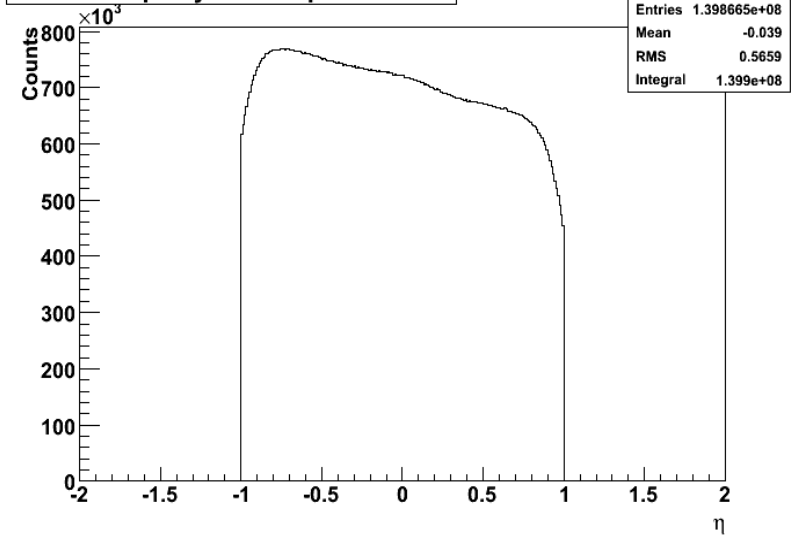
$$\begin{aligned} |dcaG| &< 3 \text{ cm} \\ n\text{Hits} &\geq 20 \\ n\text{Hits}/n\text{Poss} &> 0.52 \\ |\eta| &< 1 \\ pT &> 0.8 \text{ GeV}/c \end{aligned}$$

Track distributions after quality cuts:

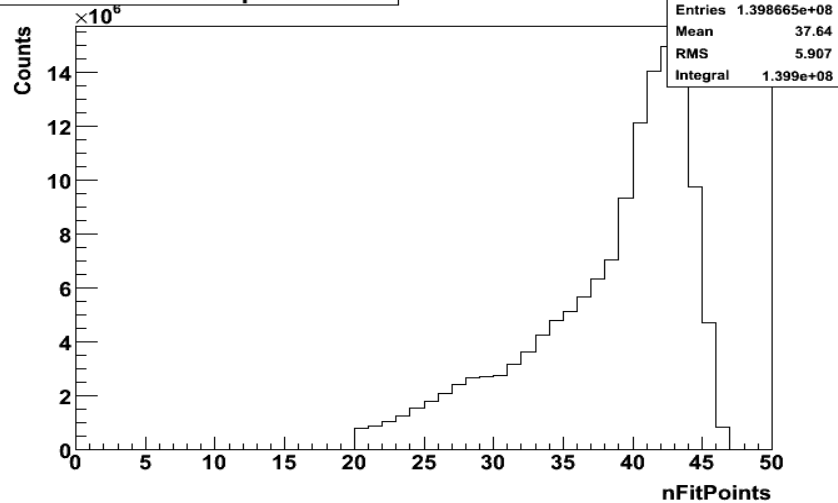
DCA for accepted tracks



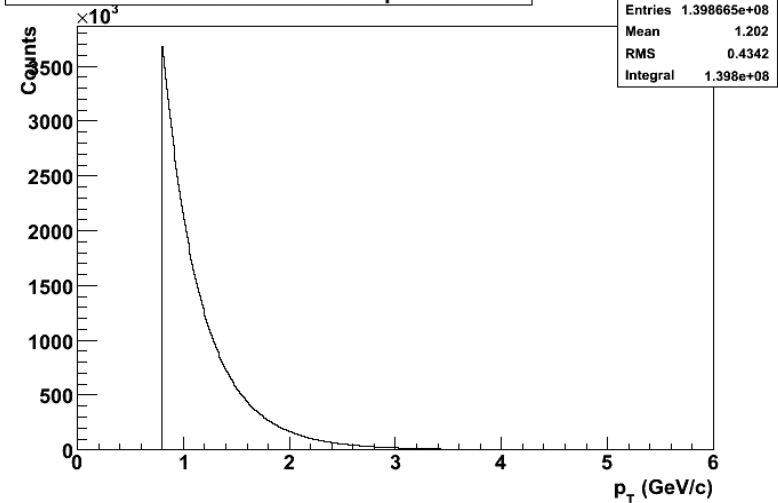
PseudoRapidity for accepted tracks



Fit Points for accepted tracks



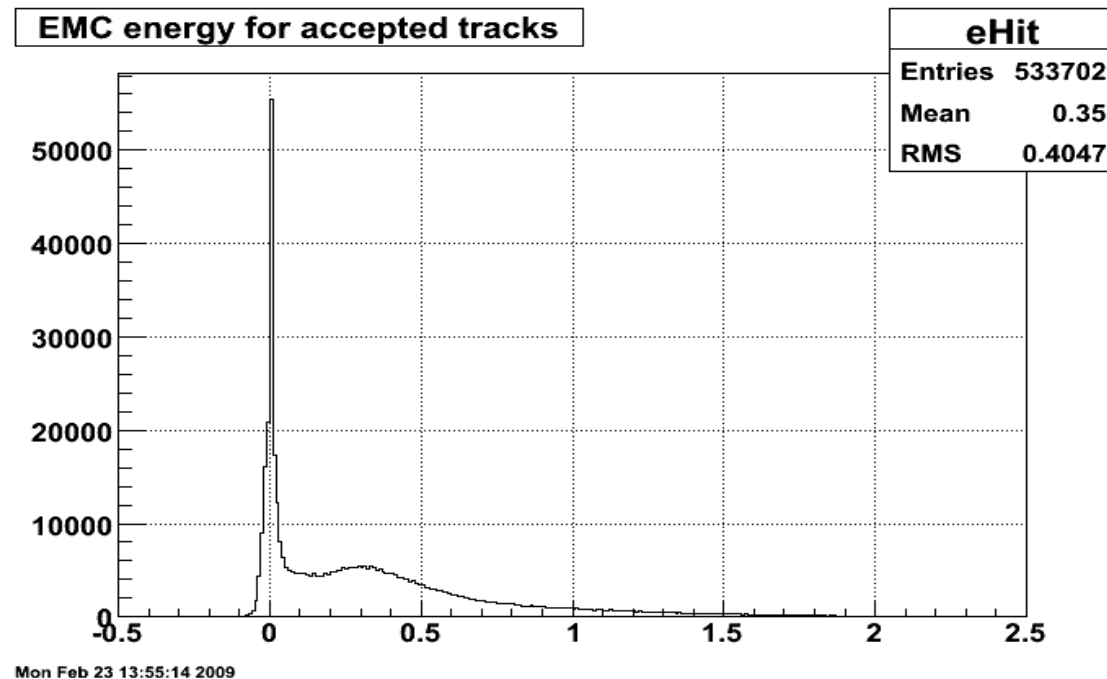
Transverse Momentum for accepted tracks



EMC tower energy

There is no plan for calibration of EMC in run8 d+Au. BTOW calibration for pp data is underway.

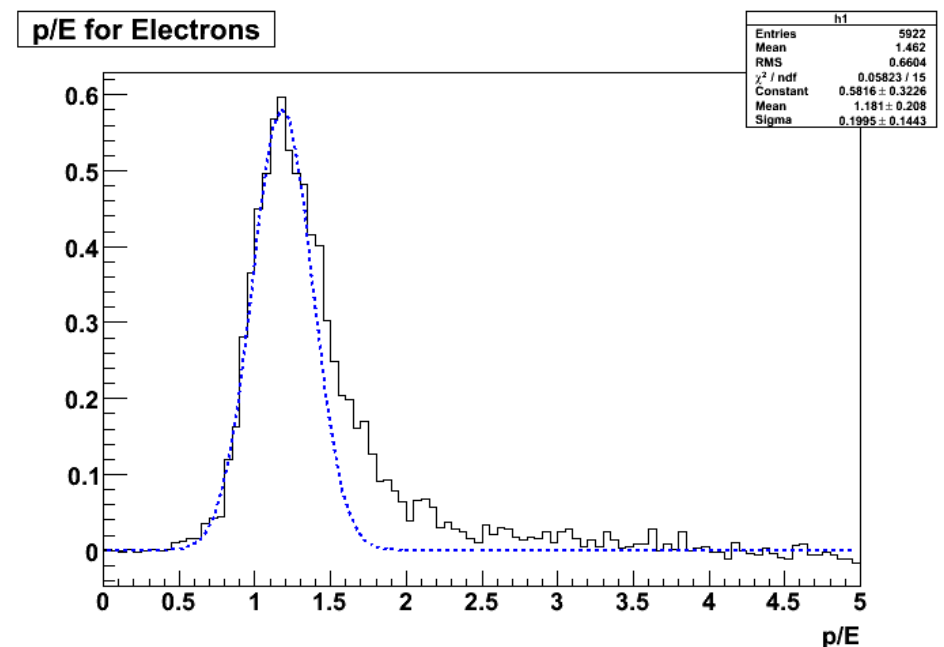
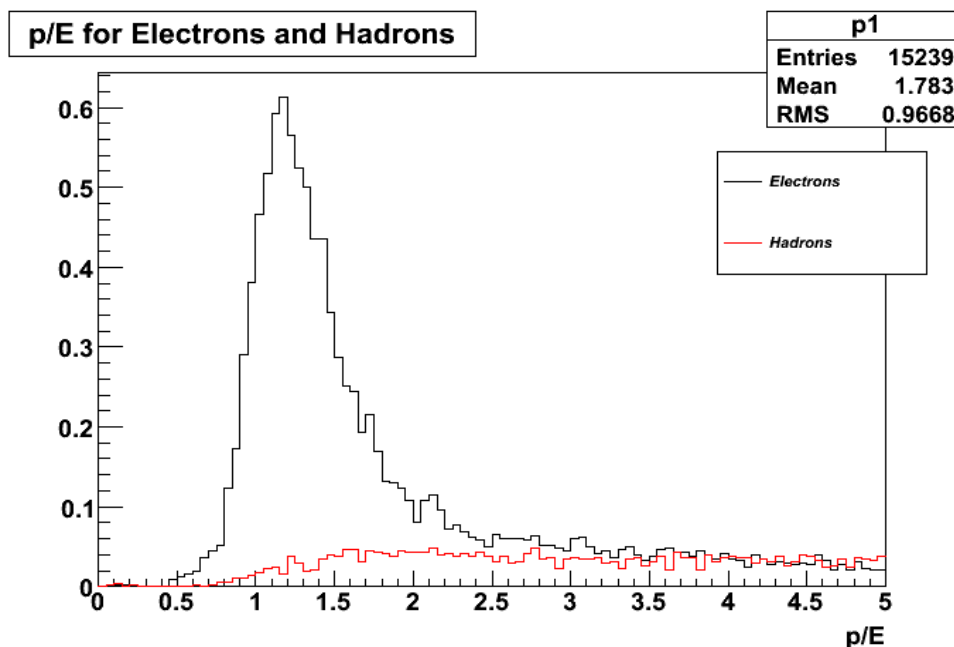
Approx. 92% of tracks in TPC are matched to tracks in EMC
Approx. 82% of those tracks have an energy $E > 0$



EMC energy for all accepted tracks on run day 5

Try to identify the electron peak in the p/E distribution. Removing events far from this peak can reduce background in the invariant mass signal.

The current p/E distribution for electrons in d+Au has a peak at p/E ~ 1.2



Electron Cuts:

$|\eta_{\text{se}}| < 3$ $|\eta_{\text{s}\pi}| > 2.5$
 $|\eta_{\text{s}P}| > 2.5$ $|\eta_{\text{s}K}| > 2.5$
 $dE/dx > 3.5 \text{ keV/cm}$
 $p_T > 1 \text{ GeV}$

Hadron Cuts:

$dE/dx < 2.5 \text{ keV/cm}$
 $p_T > 1 \text{ GeV}$

After hadron background subtraction

**Distributions scaled
for $3.5 < p/E < 5$**

Attempts to improve the purity in the p/E distribution:

Excluding tracks detected in the outer rings of the EMC
with $0.9 < |\eta| < 1.0$

(http://pdsfweb01.nersc.gov/~cpowell/dAu_2008/EMC/PoE_eta09_cut4_pt2.gif)

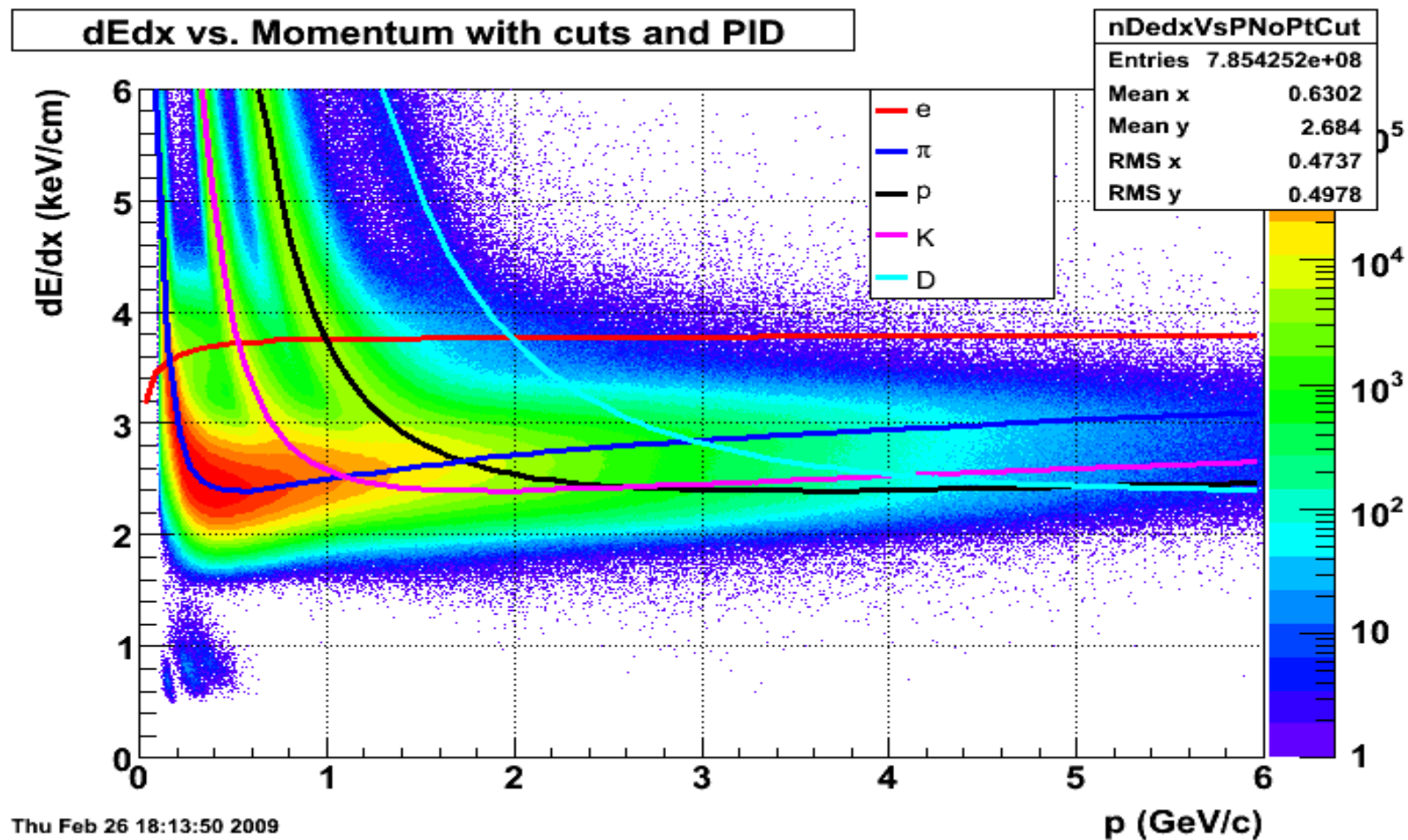
Restricting electrons to hit near the centre of the tower
so that all of the energy is in the tower.

(http://pdsfweb01.nersc.gov/~cpowell/dAu_2008/EMC/TowCut/nPoE_towCut_pt2.gif)

These reduced statistics, but did not affect the
shape of the distributions much

PID Analysis

Good tracks (no pT cut)



Particle Identification cuts:

PID3: $|\ln\sigma_e| < 3$ $|\ln\sigma_P| > 2.5$
 $|\ln\sigma_\pi| > 2.5$ $|\ln\sigma_K| > 2.5$
 $p_T > 1 \text{ GeV}/c$

The mass spectrum has been calculated for each cut, and the signal has been reconstructed using like sign background subtraction:

$$S = N_{\{+-\}} - 2 \sqrt{N_{\{++\}} N_{\{--\}}}$$

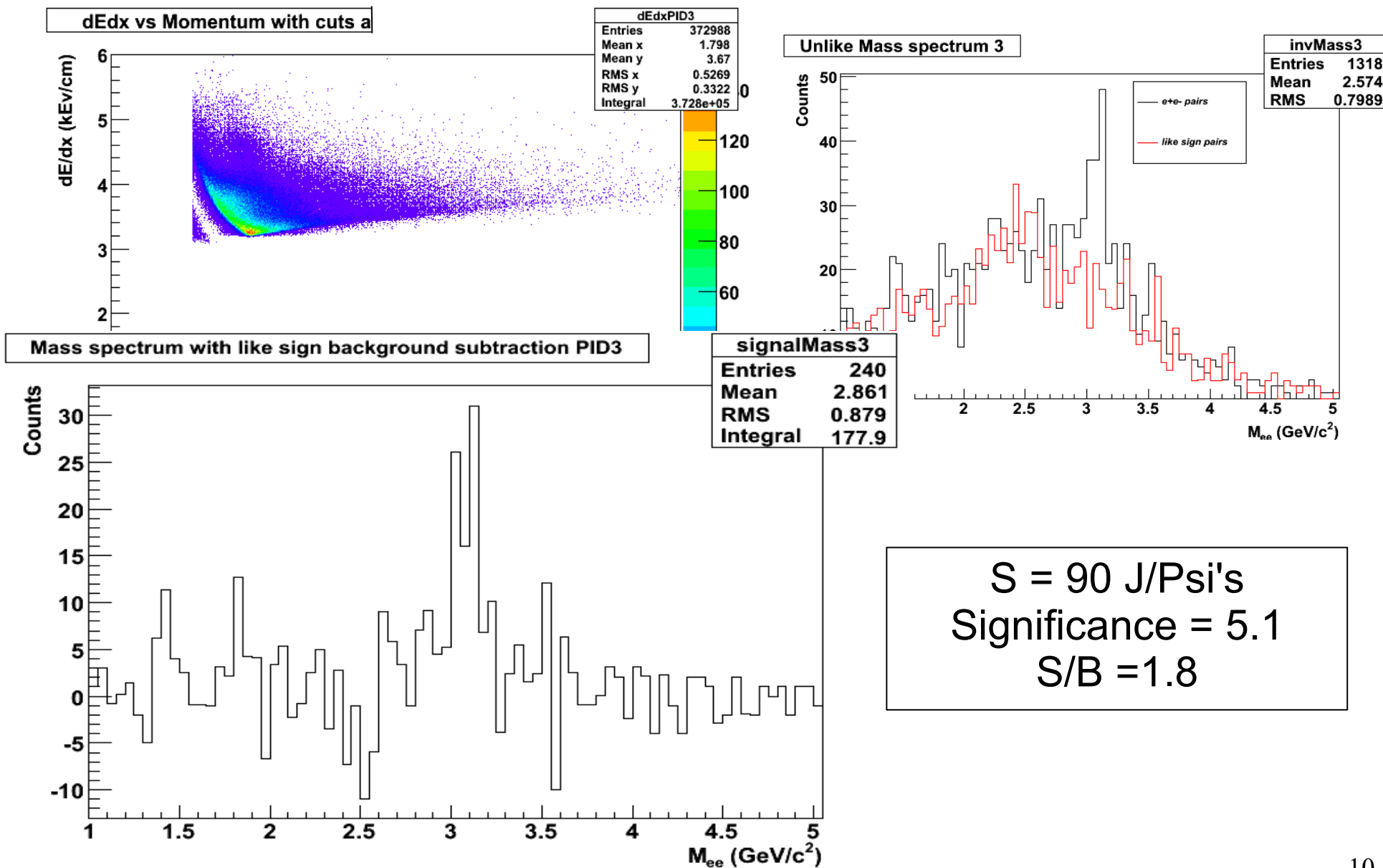
The raw number of J/Psi's has been calculated from the signal spectrum by counting the number of e^+e^- pairs with $2.9 \text{ GeV} < M_{\{ee\}} < 3.2 \text{ GeV}$.

The significance of the peak has also been calculated:

$$\text{Significance} = S / \delta S$$

where $\delta S = \sqrt{N_{\{++\}} + N_{\{--\}} + N_{\{+-\}}}$

Accepted electrons



Only use tracks with EMC energy $E > 0$ and $p/E < 2.3$

PID10:

if($|\sigma_e| < 3$ && $|\sigma_P| > 2.5$,
&& $|\sigma_\pi| > 2.5$ && $|\sigma_K| > 2.5$) {

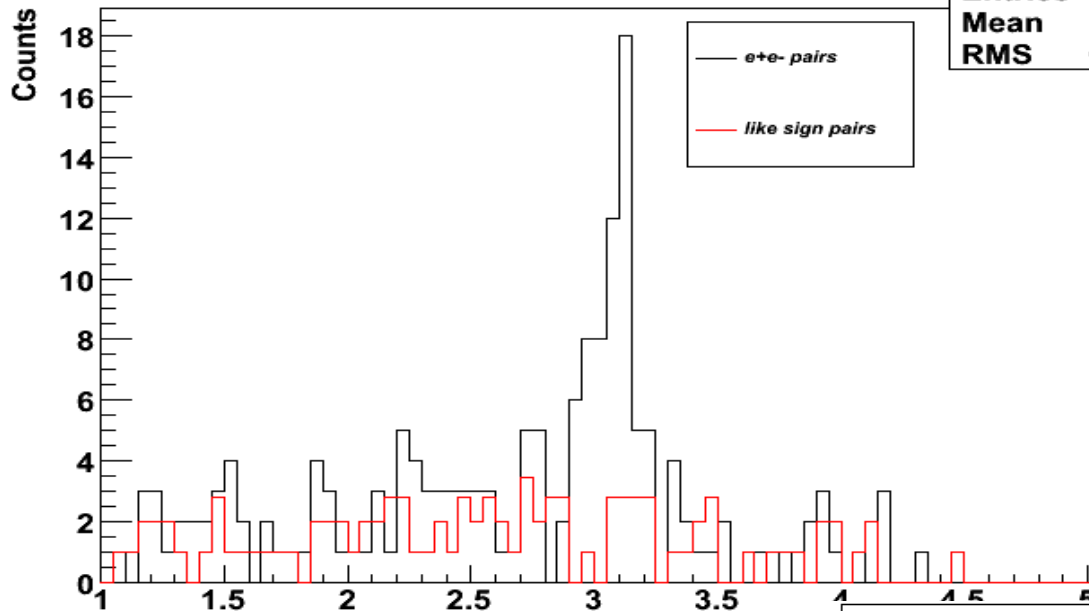
if($E > 0$ && $p/E < 2.3$)
store info

else
continue

}

After background subtraction:

Unlike Mass spectrum 10

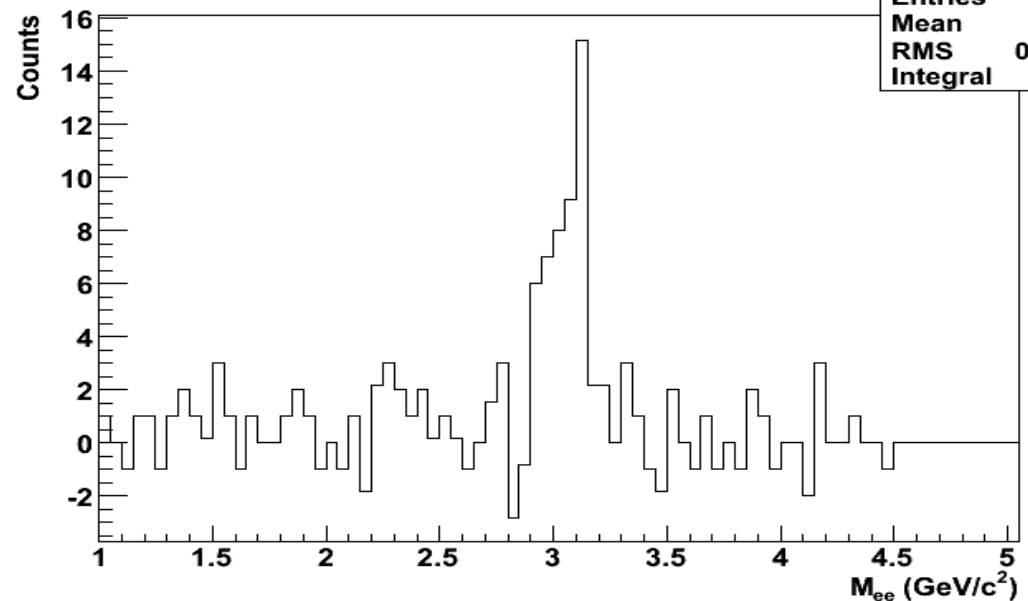


| invMass10 | |
|-----------|--------|
| Entries | 200 |
| Mean | 2.654 |
| RMS | 0.7497 |

Reduction in
background is mostly
due to requiring tracks
matched in EMC

S = 48 J/Psi's
Significance = 5.8
S/B = 5.7

Mass spectrum with like sign background subtraction PID10



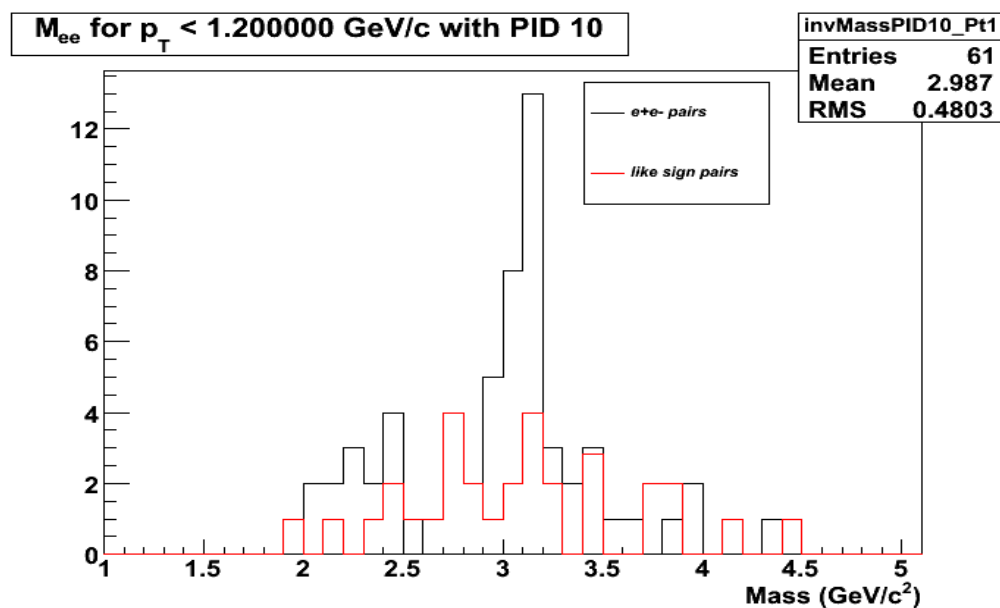
| signalMass10 | |
|--------------|--------|
| Entries | 240 |
| Mean | 2.821 |
| RMS | 0.7639 |
| Integral | 75.59 |

pT bins using PID 10

Caution: Full statistic results include events with corrupt scalars. These events cannot be trusted, but only make up at most 0.6% of the data.

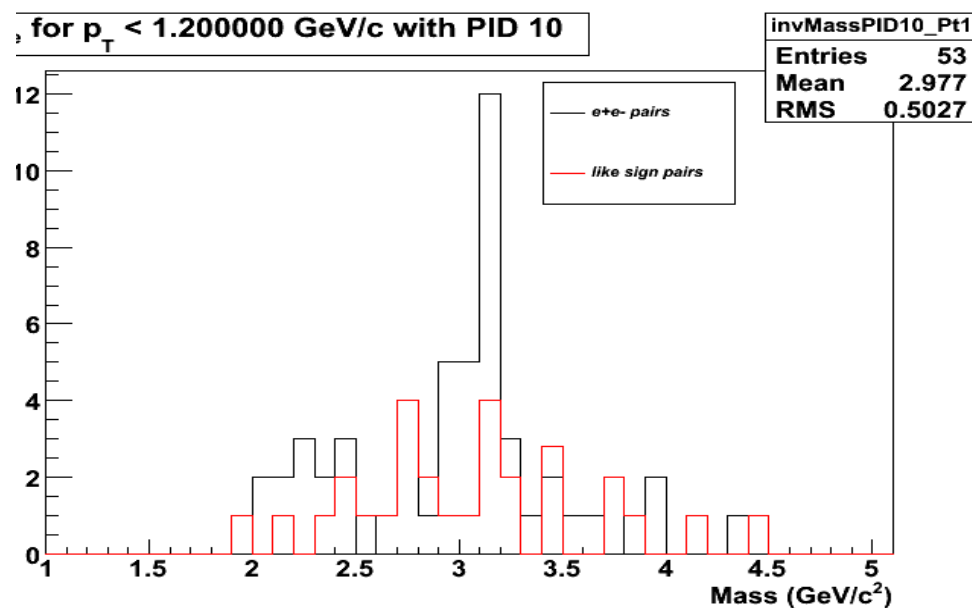
pT < 1.2 GeV

Full statistics



$S = 19$ J/Psi's
Significance = 3.3
S/B = 4.1

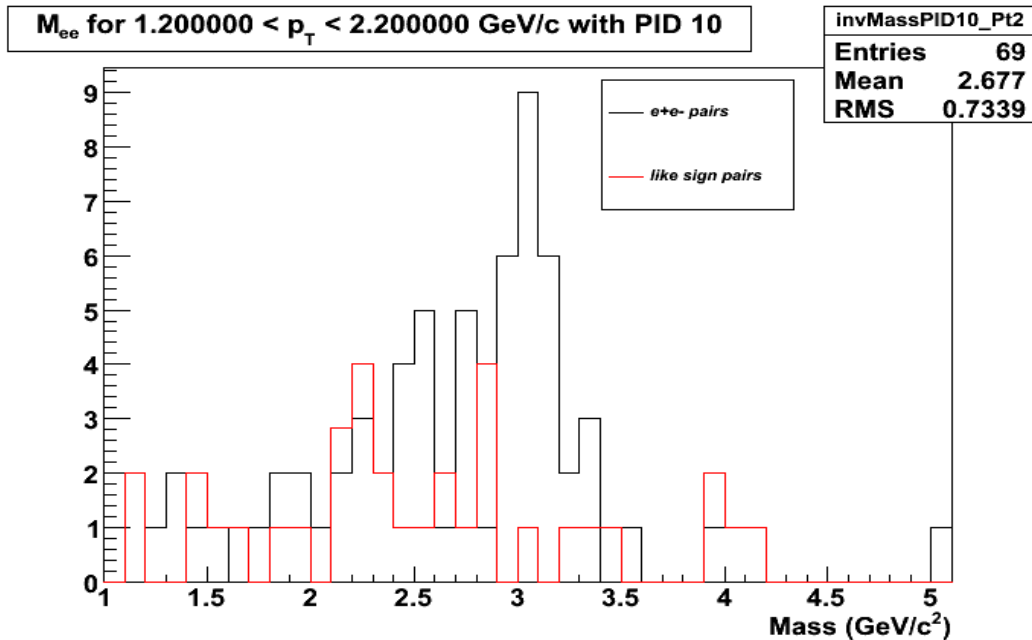
83% of statistics



$S = 16$ J/Psi's
Significance = 3
S/B = 3.9

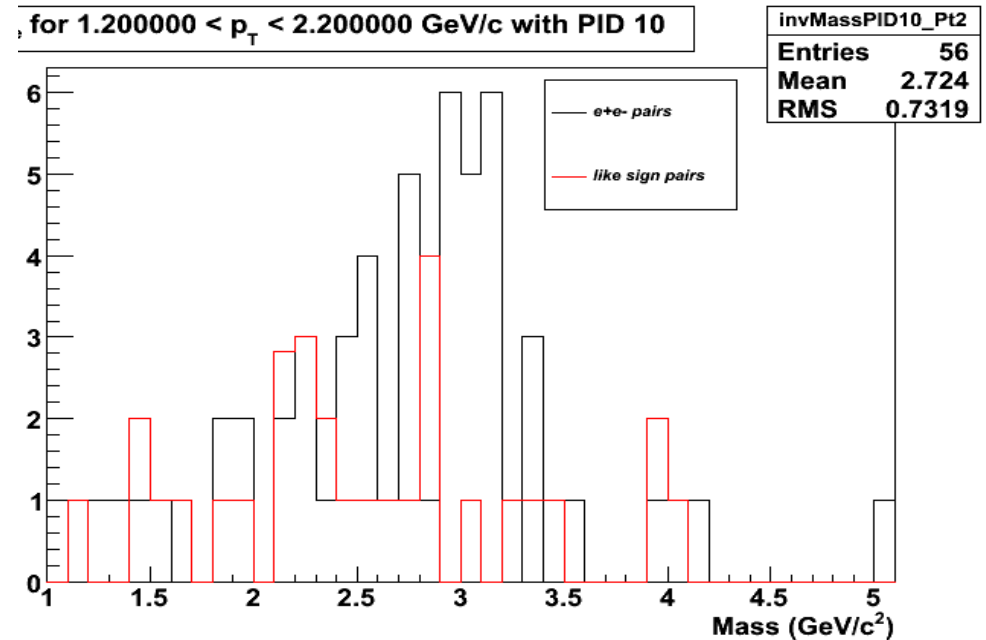
$1.2 < p_T < 2.2 \text{ GeV}$

Full statistics



$S = 20 \text{ J/Psi's}$
Significance = 4.3
 $S/B = 21$

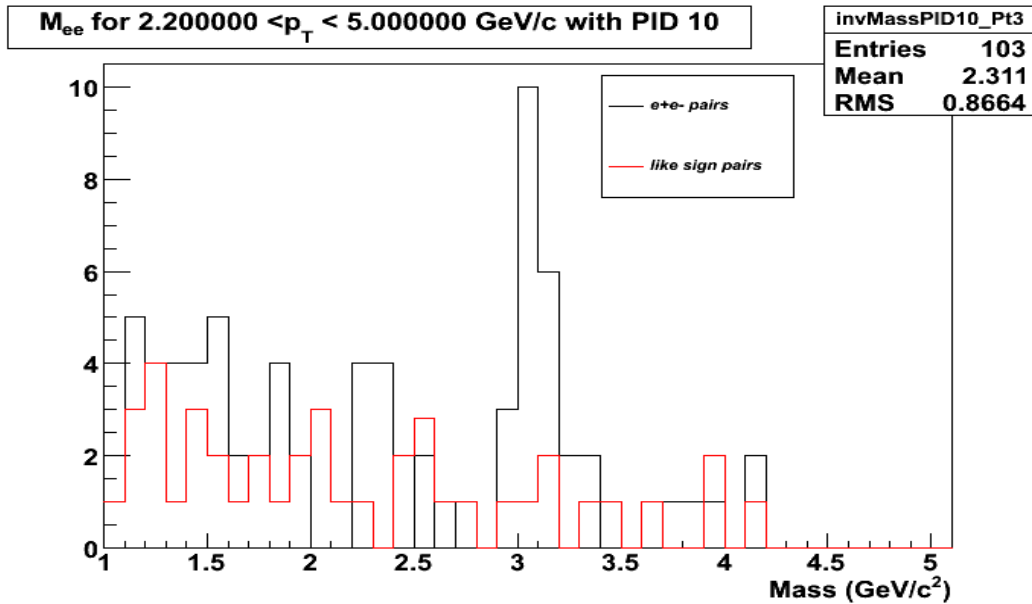
83% of statistics



$S = 16 \text{ J/Psi's}$
Significance = 3.8
 $S/B = 17$

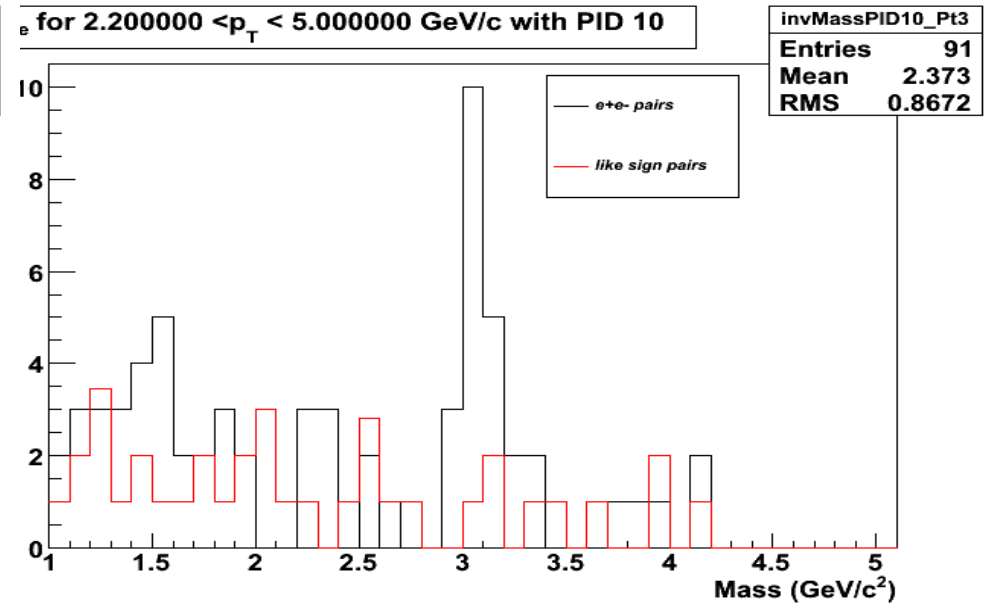
$2.2 < p_T < 5 \text{ GeV}$

Full statistics



$S = 15 \text{ J/Psi's}$
Significance = 3.1
 $S/B = 3.7$

83% of statistics

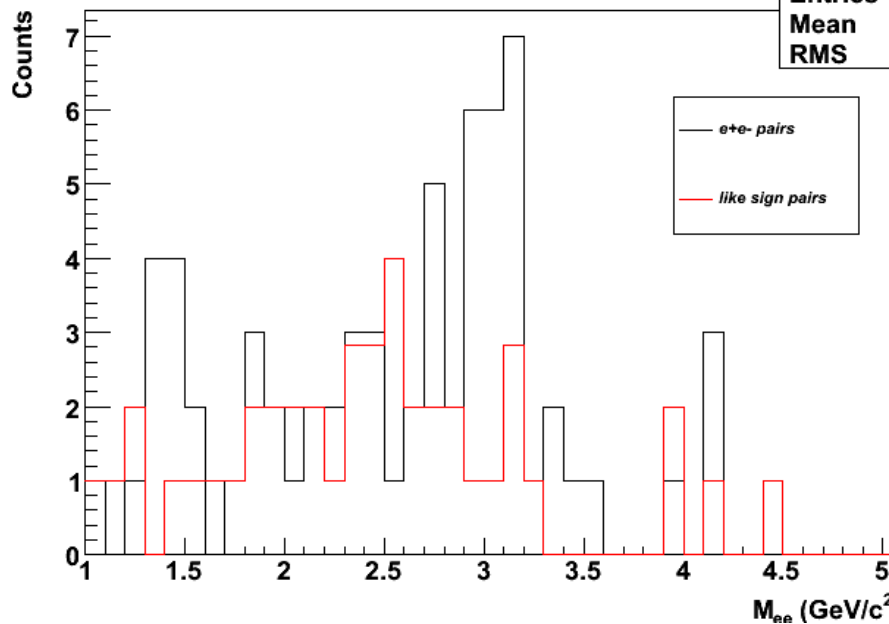


$S = 15 \text{ J/Psi's}$
Significance = 3.3
 $S/B = 4.2$

0 – 20% Central using PID 10

Require refMultFtpcEast > 12

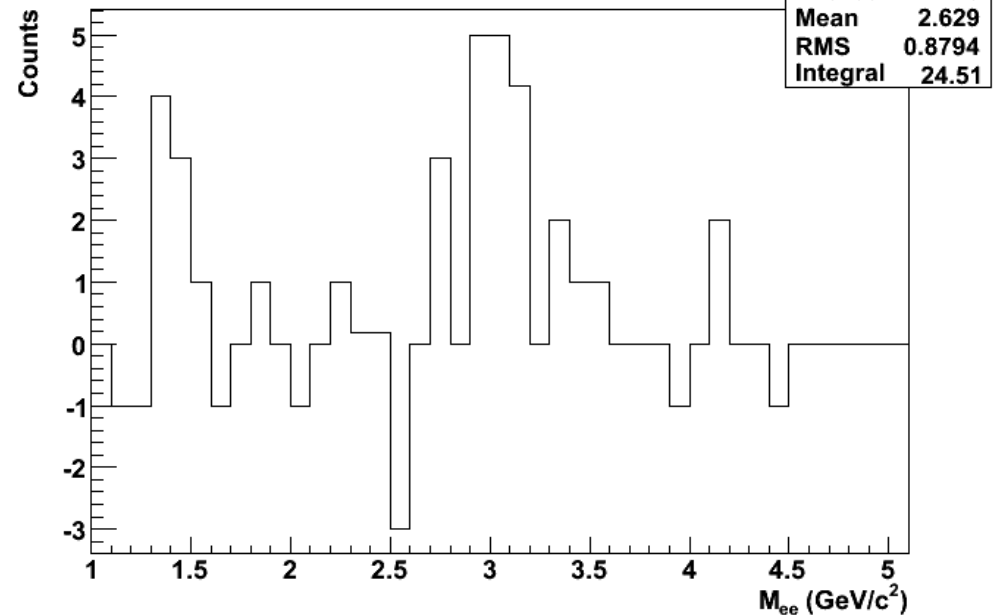
Unlike Mass spectrum 10



| invMass10 |
|-----------|
| Entries |
| Mean |
| RMS |

After background subtraction:

Mass spectrum with like sign background subtraction PID10



S = 14 J/Psi's
Significance = 2.9
S/B = 3.9

Table summarising J/Ψ signal information

Full pT Range (83% of statistics)

| PID | Central | Jpsi's | Sig | S/B |
|------------|----------------|---------------|------------|------------|
| 3 | 0-100% | 90 | 5.1 | 1.8 |
| 10 | 0-100% | 55 | 6.2 | 5.5 |
| 10 | 0-20% | 14 | 2.9 | 3.9 |

no p/E cut

E>0 && p/E <2.3

E>0 && p/E <2.3

pT bins for PID 10 (83%) (Full)

| Jpsi pT | Jpsi's | Sig | S/B |
|----------------------|---------------|------------|------------|
| pT < 1.2 GeV/c | 16 (19) | 3 (3.3) | 3.9 (4.1) |
| 1.2 < pT < 2.2 GeV/c | 16 (20) | 3.8 (4.4) | 17 (21) |
| 2.2 < pT < 5 GeV/c | 15 (15) | 3.3 (3.1) | 4.2 (3.6) |

Requiring tracks to have EMC information drastically reduces the background in the invariant mass spectrum and increases the signal to background ratio.

There should be a slight improvement of statistics with the full d+Au data set.

Summary

- A clear J/ψ signal with a high significance has been identified using the TPC.
- Adding EMC information for particle identification improves this signal
- However, EMC has not been calibrated; the mean of the electron peak in the p/E distribution is ~ 1.2 .
- Invariant mass spectrums show a clear peak in 3 pT bins.
- A peak can be identified for 0-20% central collisions.
- Low statistics impact on effective like-sign background subtraction.

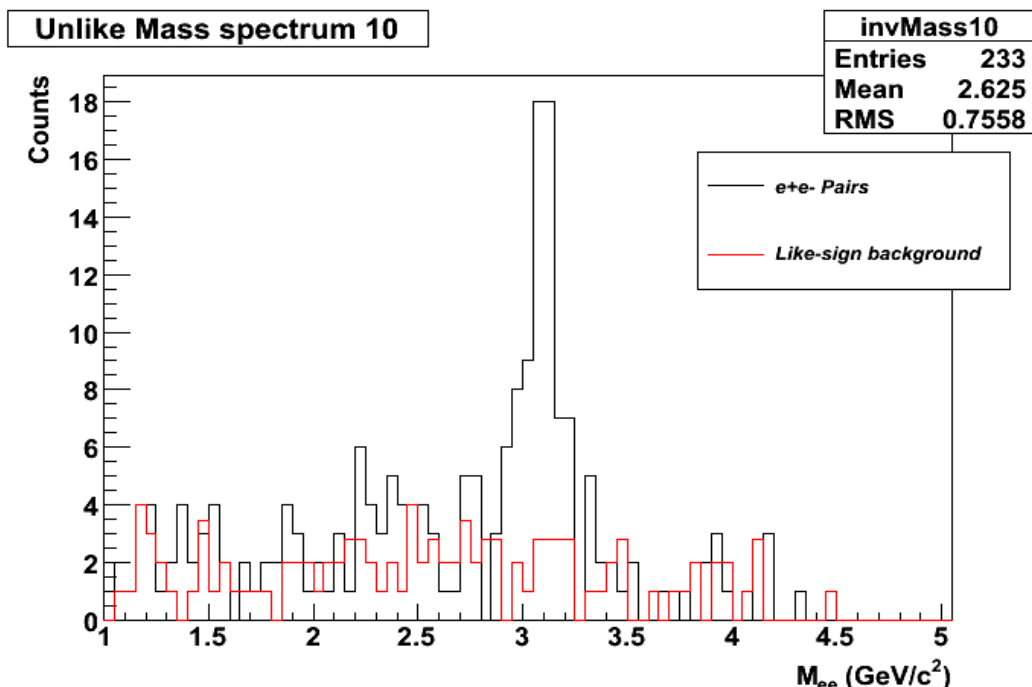
To Do

- Embedding: a sample for J/ψ in d+Au has been produced, QA is underway
- Initial test samples indicate the line shape is much narrower than the data indicates.
- The remaining 17% of the data will be included shortly
- Alternative background subtraction methods can be investigated.

Backup Slides

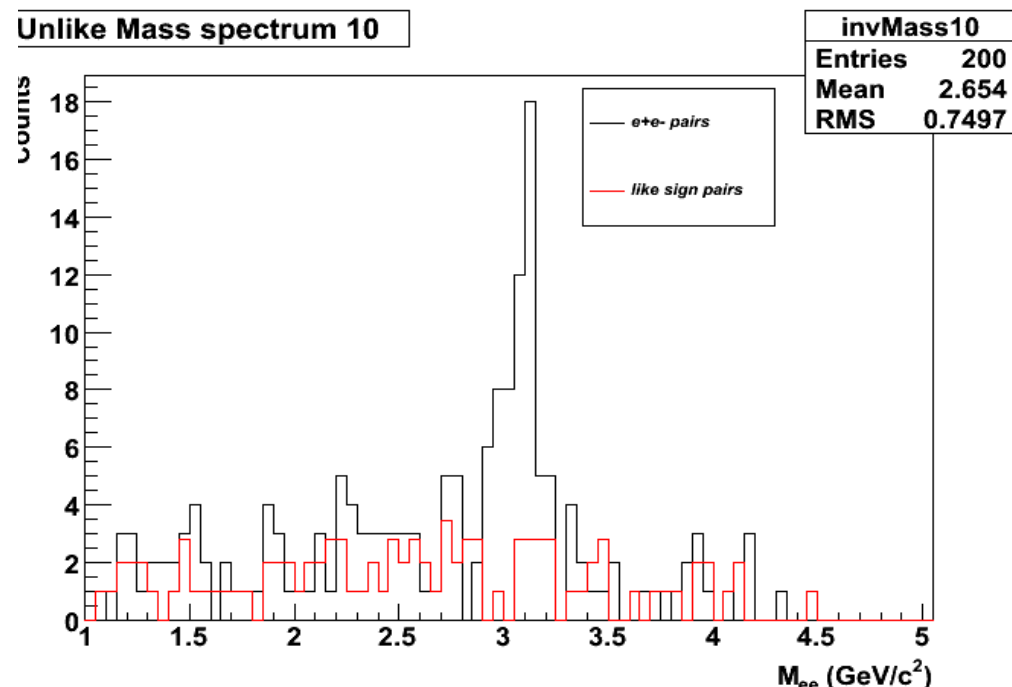
Estimate of improvement in statistics

Caution: Full statistic results include events with corrupt scalers...



Full statistics

S = 55 J/Psi's
Significance = 6.2
S/B = 5.5



83% of statistics

S = 48 J/Psi's
Significance = 5.8
S/B = 5.7

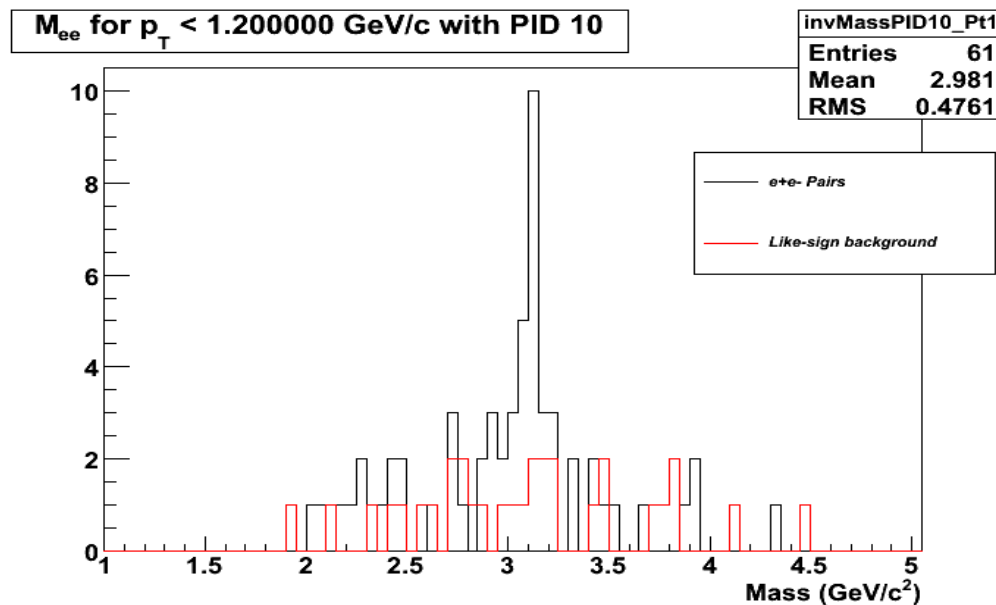
pT bins using PID 10

(No rebinning)

Caution: Full statistic results include events with corrupt scalars. These events cannot be trusted, but only make up at most 0.6% of the data.

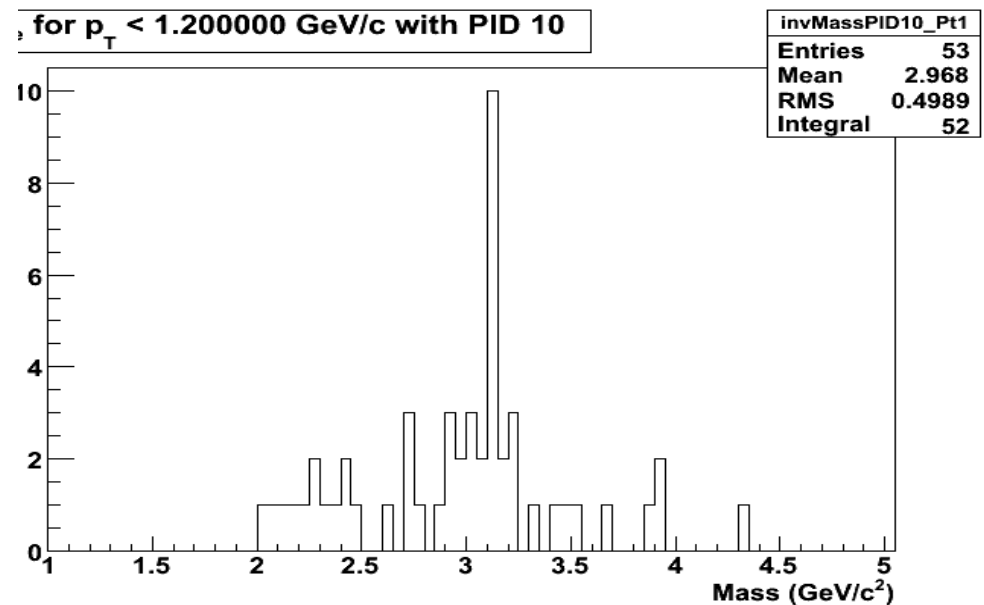
pT < 1.2 GeV

Full statistics



$S = 19$ J/Psi's
Significance = 3.3
S/B = 4.1

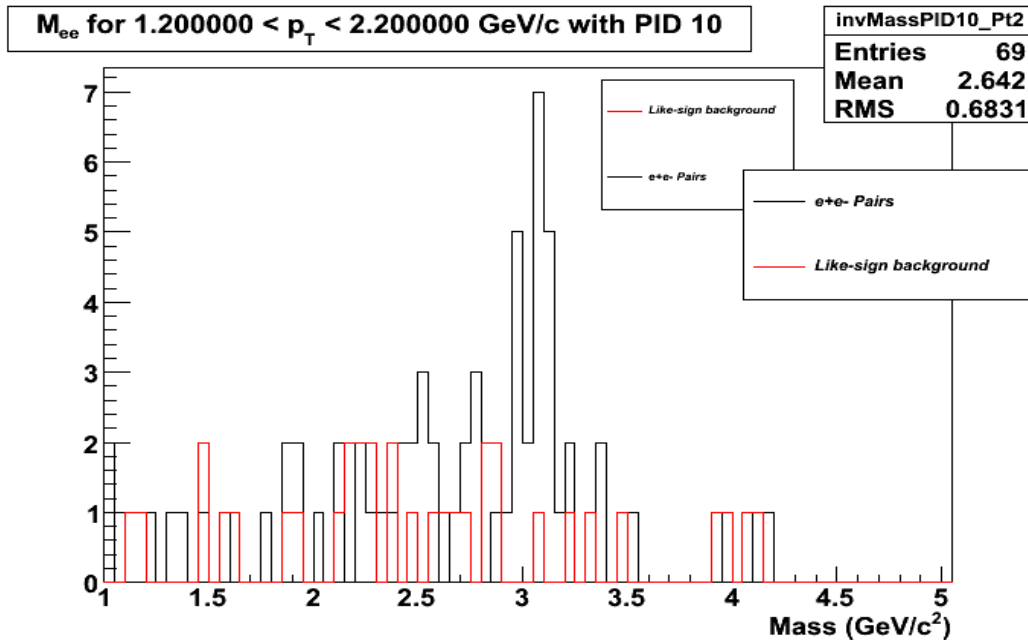
83% of statistics



$S = 16$ J/Psi's
Significance = 3
S/B = 3.9

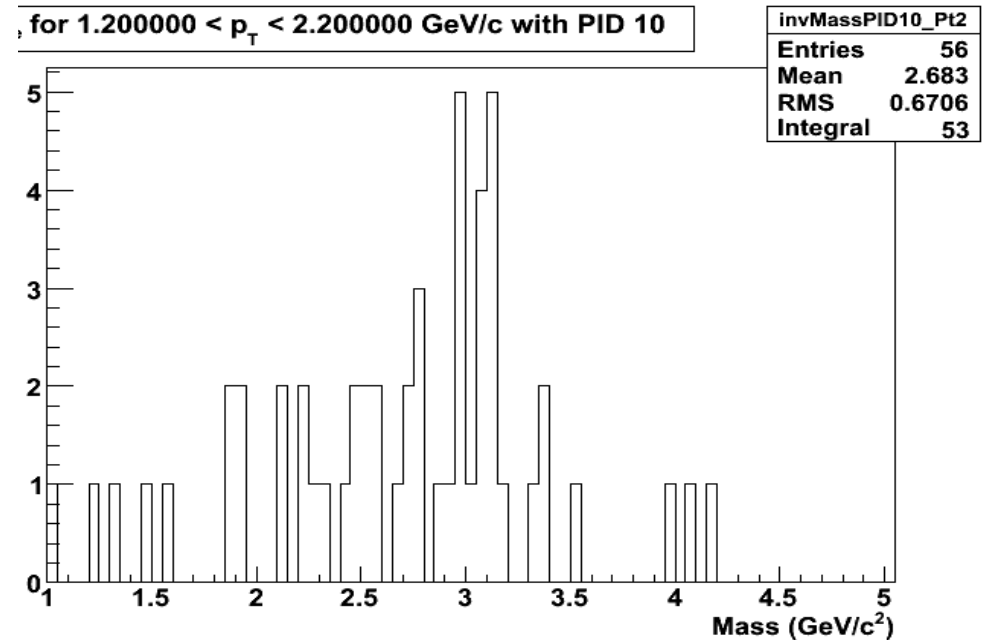
$$1.2 < p_T < 2.2 \text{ GeV}$$

Full statistics



$S = 20 \text{ J/Psi's}$
Significance = 4.3
 $S/B = 21$

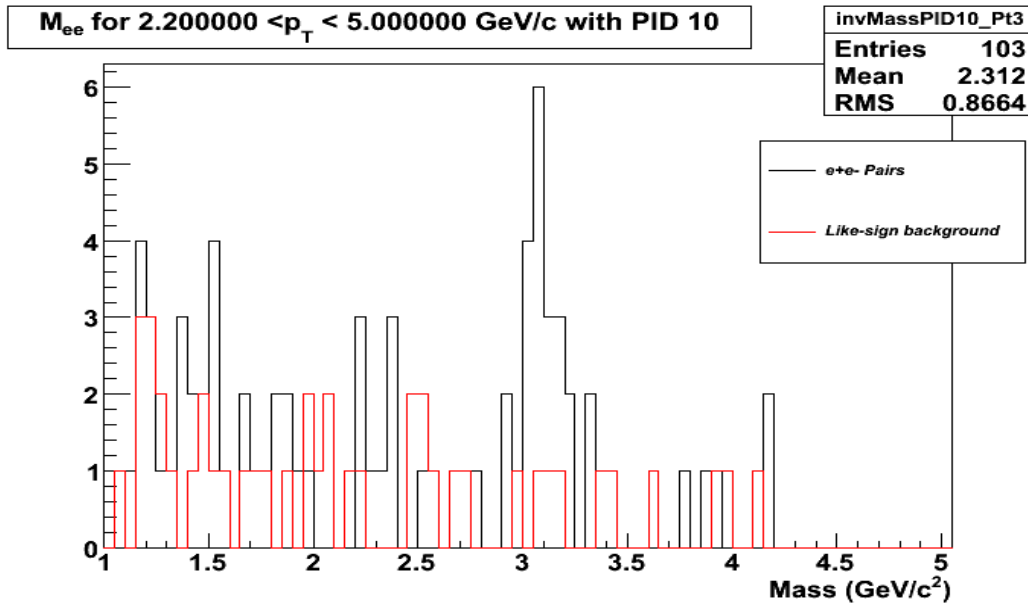
83% of statistics



$S = 16 \text{ J/Psi's}$
Significance = 3.8
 $S/B = 17$

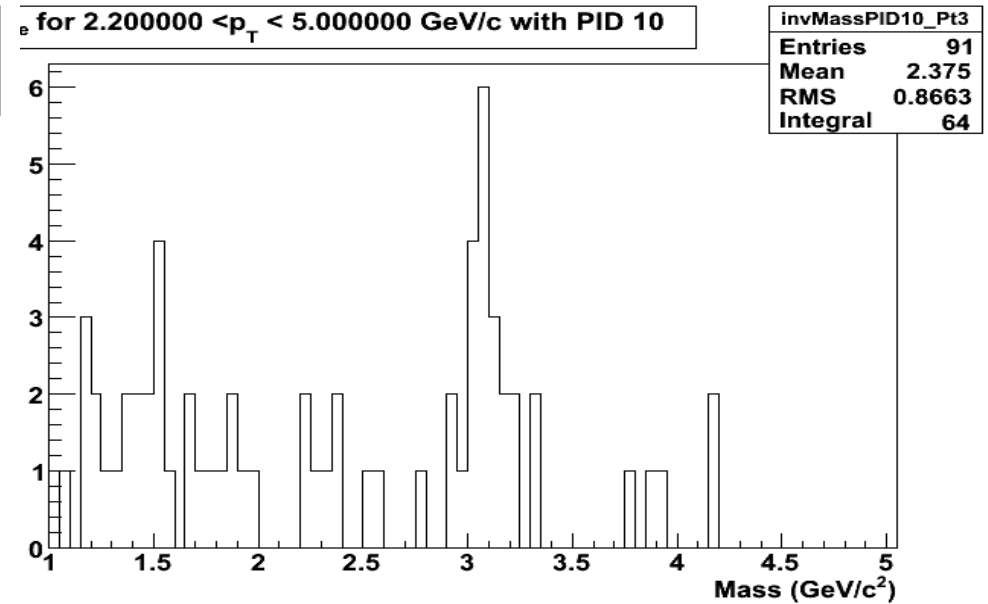
$2.2 < p_T < 5 \text{ GeV}$

Full statistics



$S = 15 \text{ J/Psi's}$
Significance = 3.1
 $S/B = 3.7$

83% of statistics

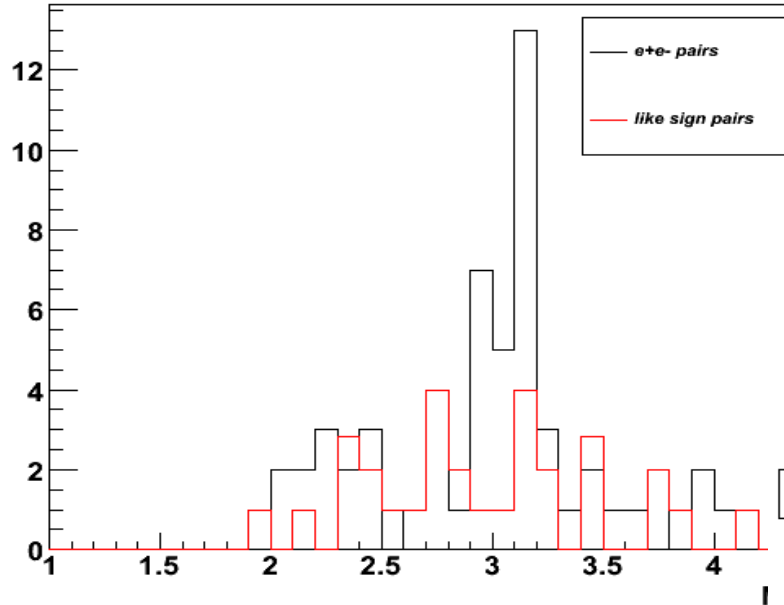


$S = 15 \text{ J/Psi's}$
Significance = 3.3
 $S/B = 4.2$

pT bins using PID 10

(Different pT bins)

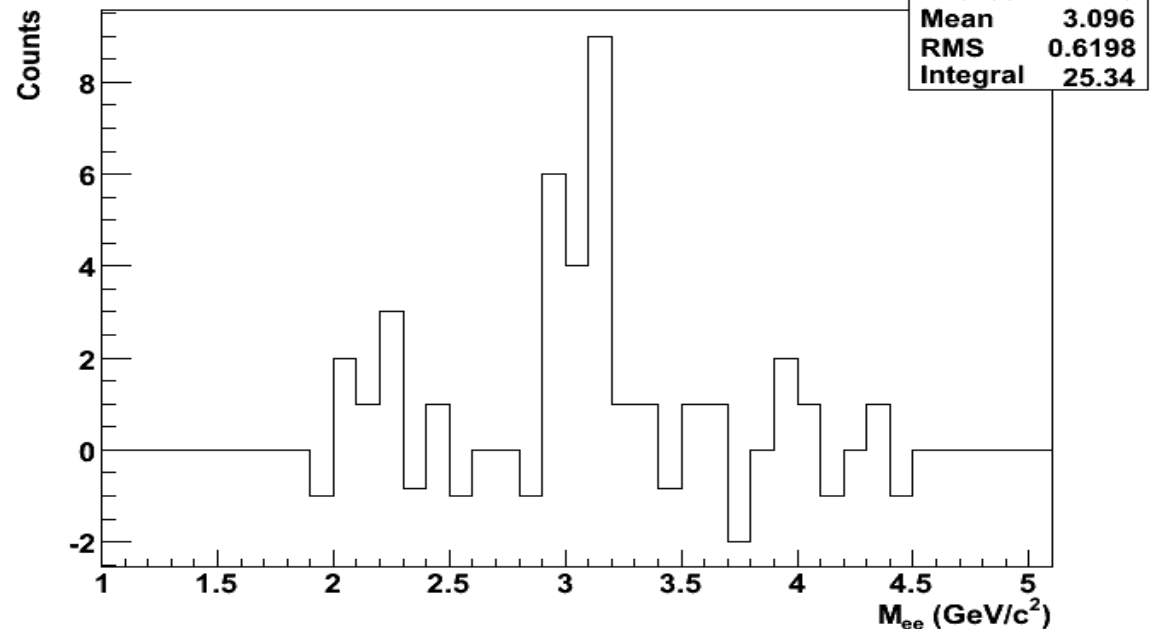
M_{ee} for $p_T < 1.300000$ GeV/c with PID 10



| invMassPID10_Pt1 | |
|------------------|--------|
| Entries | 57 |
| Mean | 2.998 |
| RMS | 0.5053 |

pT < 1.3 GeV

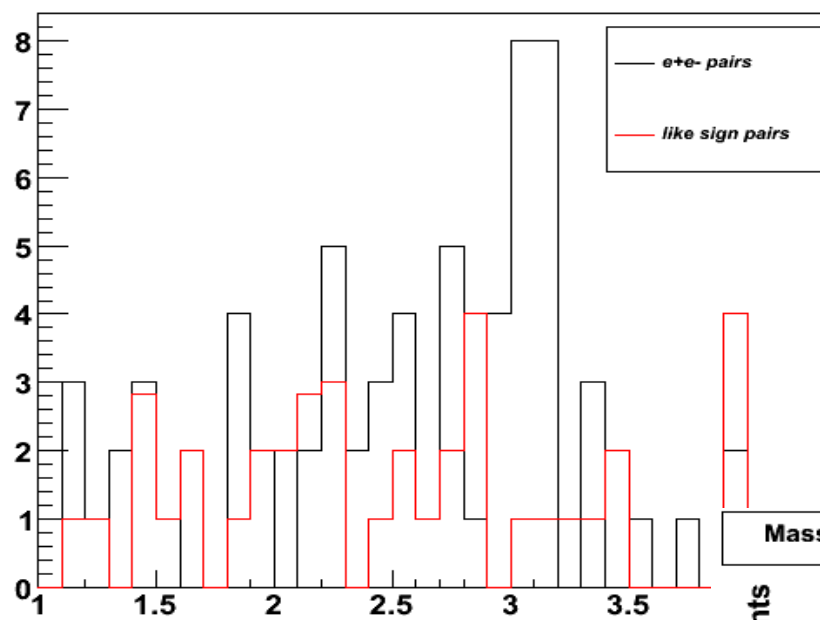
Mass spectrum for $p_T < 1.300000$ GeV/c and PID 10



$S = 19$ J/Psi's
Significance = 3.4
 $S/B = 4.4$

Invariant mass with like-sign background subtraction

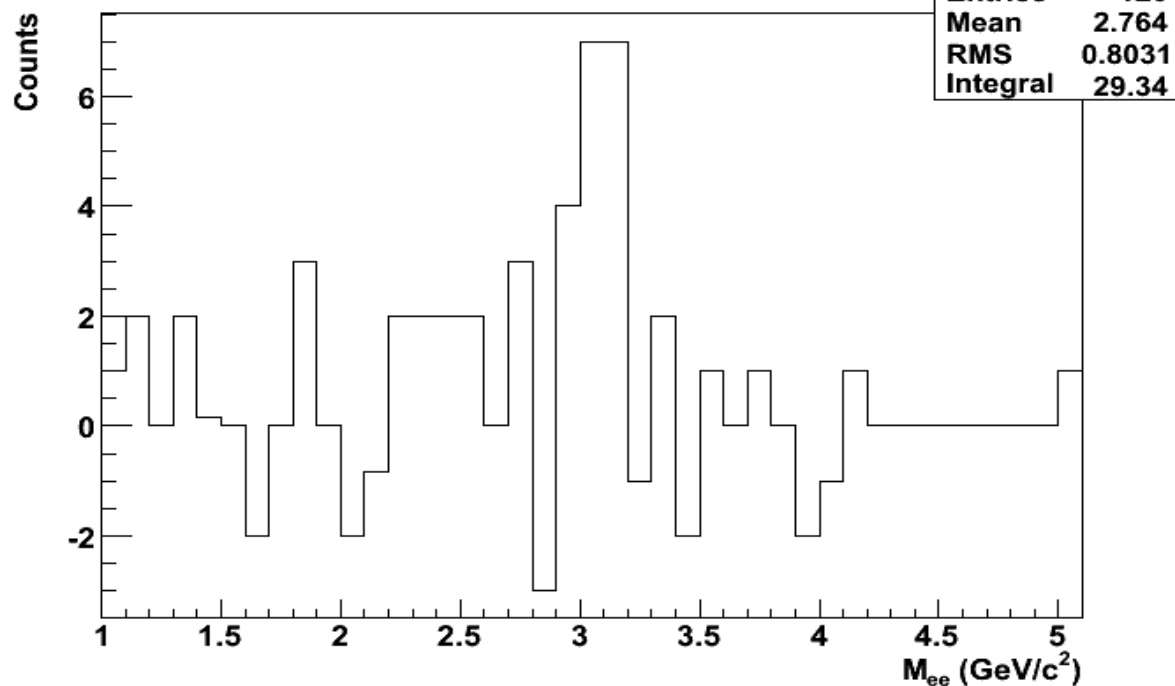
M_{ee} for $1.300000 < p_T < 2.600000$ GeV/c with PID 10



| invMassPID10_Pt2 | |
|------------------|--------|
| Entries | 79 |
| Mean | 2.588 |
| RMS | 0.7958 |

$1.3 < p_T < 2.6$ GeV

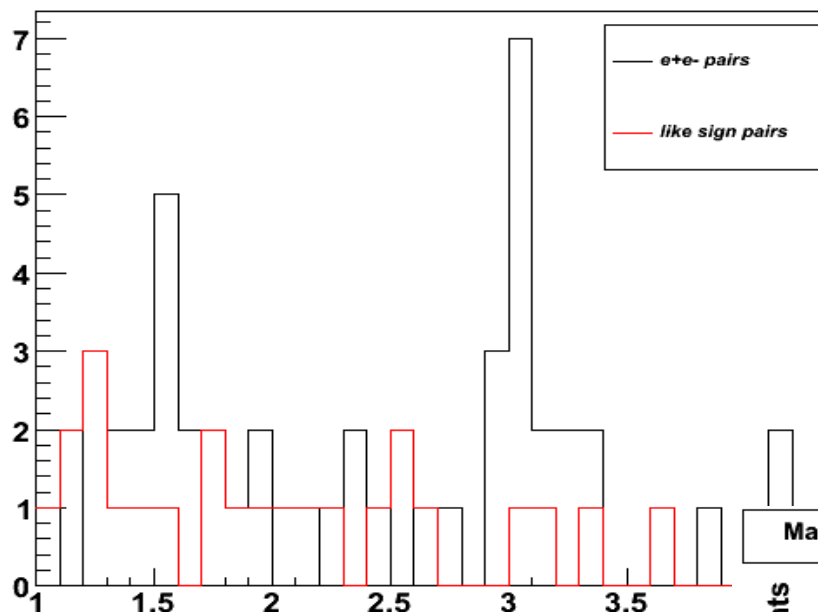
Mass spectrum for $1.300000 < p_T < 2.600000$ GeV/c and PID 10



$S = 18$ J/Psi's
Significance = 3.9
 $S/B = 10$

Invariant mass with like-sign background subtraction

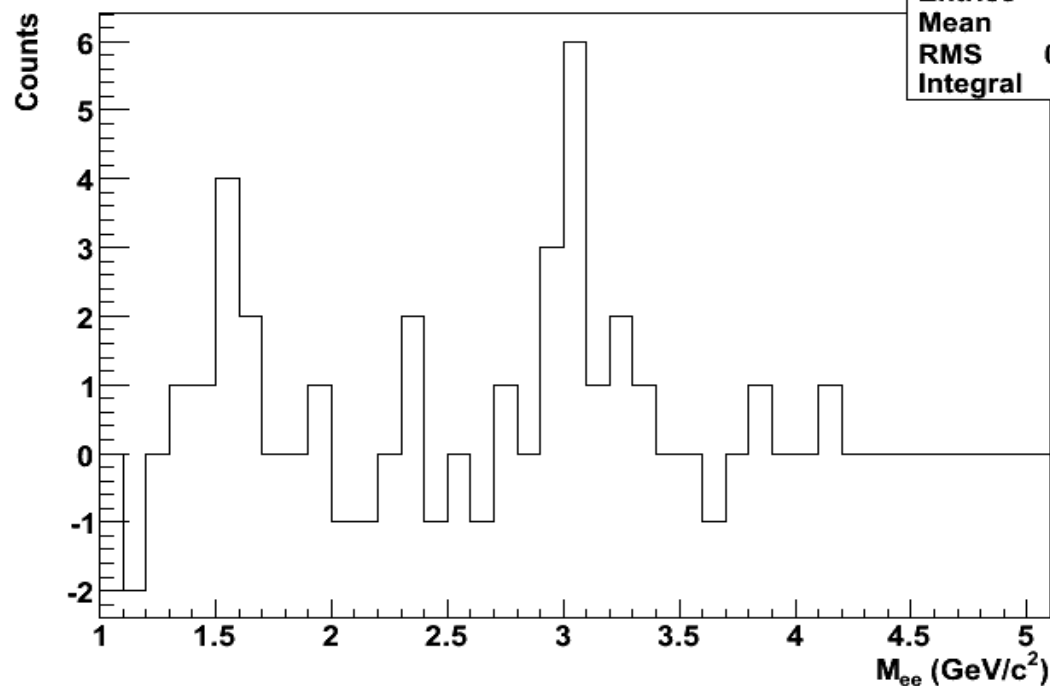
M_{ee} for $2.600000 < p_T < 5.000000$ GeV/c with PID 10



| invMassPID10_Pt3 | |
|------------------|-------|
| Entries | 64 |
| Mean | 2.386 |
| RMS | 0.853 |

$2.6 < p_T < 5$ GeV

Mass spectrum for $2.600000 < p_T < 5.000000$ GeV/c and PID 10



| signalMass10_Pt3 | |
|------------------|--------|
| Entries | 120 |
| Mean | 2.503 |
| RMS | 0.8125 |
| Integral | 20 |

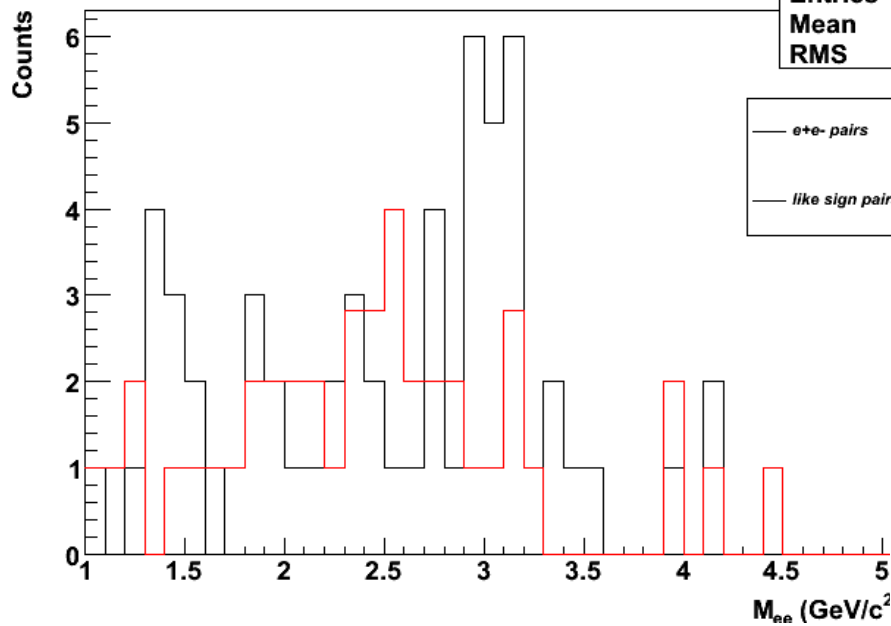
$S = 10$ J/Psi's
Significance = 2.7
 $S/B = 4$

Invariant mass with like-sign background subtraction

0 – 20% Central using PID 10

Require refMultFtpcEast > 12

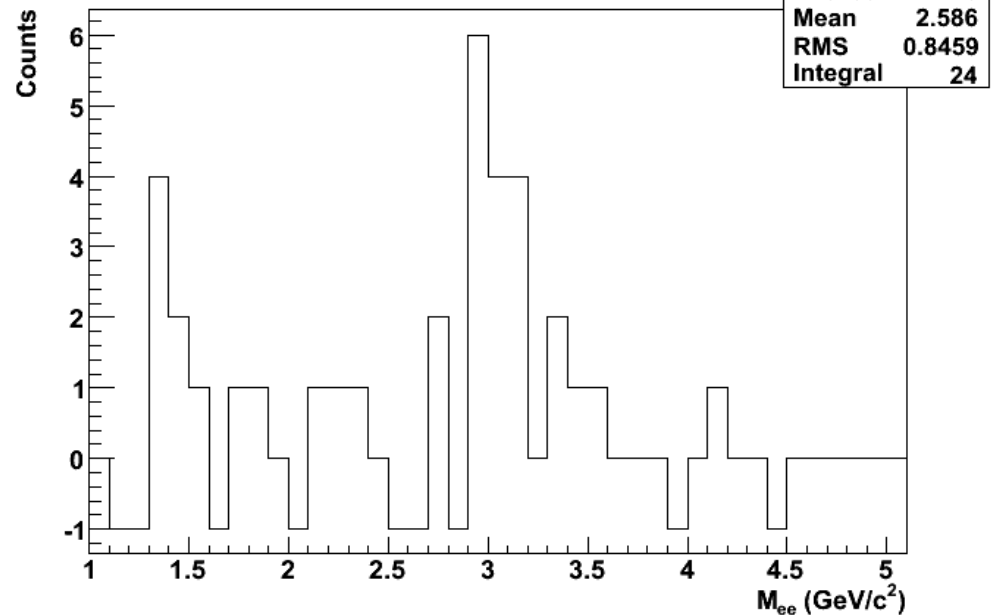
Unlike Mass spectrum 9



Require tighter cut::

$$p/E < 2$$

Mass spectrum with like sign background subtraction PID9



S = 14 J/Psi's
Significance = 3.1
S/B = 6